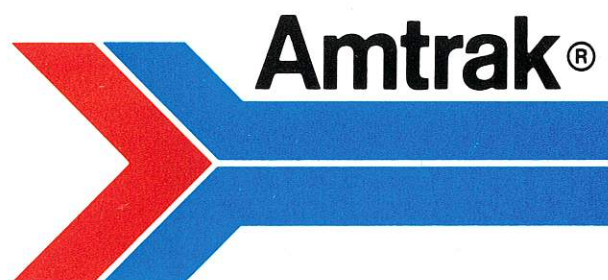


NATIONAL RAILROAD PASSENGER CORPORATION



**THE OUT OF SLOT
THEORY
FACT OR MYTH**

**National Railroad Passenger Corporation
Contract Management
January 2, 1996**

NATIONAL RAILROAD PASSENGER CORPORATION
CUSTOMER SERVICES & SUPPORT DEPARTMENT

INTEROFFICE MEMORANDUM

January 2, 1996

TO: D. F. Sullivan

FROM: J. L. Larson *J. L. Larson*

SUBJECT: Out of Slot Study

We repeatedly hear from various railroads, as an excuse for late train operations, that late trains become later because they are received "out of slot." Clearly this has been a premise within the industry for many years, or perhaps generations. The following study, conducted in the summer and autumn months of 1995, addressed the question of whether late trains lose more time than on-time trains. This paper has been prepared for the NRPC Officers' Quarterly Meeting on January 15, 1996.

There has been a perception within the railroad industry that on-time trains have a tendency to stay on time while late trains have a strong tendency to get later. There is probably no historical data to support or refute this premise, but the feeling has been fairly universal throughout the industry. This theory is likely to have been based on actual observations that all seasoned operating personnel have surely experienced during their careers; however, a systematic tally of "all" late trains may also have shown these occurrences to have been the exception instead of the norm.

The ability to keep a train on time is to a great extent in the hands of the train dispatcher. Although there are unforeseen delays such as mechanical or signal delays or delays caused by outside parties, the overall performance of a train, especially with respect to other trains, is under the dispatcher's control.

All schedules contain recovery time, for all contingencies, which is time in addition to running time and dwell time. This amount of time, which is a critical element in good schedule construction, is also known by other less proper names such as fat, pad, or rubber. A good schedule will have between 6 and 8 percent recovery time built in. This is not a significant amount of time in shorter schedules. It is generally less than 5 minutes per hour or less than 10 minutes per 100 miles; however, it can become a significant amount of time on long distance trains. Trains between Chicago and the West Coast generally have three or more hours of recovery time.

A train is not late until the minutes of delay exceeds the amount of available recovery time.

An example of the effect of "out of slot" would be an intercity passenger train "swimming upstream" against a commuter rush or following commuter trains where all moves are closely scheduled. Under such circumstances a train that is only five or ten minutes late may be in the wrong place at the wrong time. When it is out of slot, it may have to follow a local train or wait for an opposing train, with disastrous results from an on-time performance standpoint.

A second example of the "out of slot" effect would be on the San Diego Line, the preponderance of which is single track with nine intercity passenger trains each way daily, plus commuter operations and a limited freight train operation. Train 1, a hypothetical late train on the single track portion of the San Diego Line, will be delayed by or in turn will delay opposing Trains 2 and 4, and they in turn will delay opposing Trains 3, 5 and 7 and so on. This situation, which is known as the "domino effect," is particularly acute on the San Diego Line where an unreliable signal system compounds the problem.

Fortunately, commuter territory and the San Diego Line are atypical of Amtrak operations throughout the United States. Commuter territory represents only about 4% of the Amtrak system mileage and the types of problems cited above are materially reduced as the number of main tracks increase, especially where three or more main tracks are in service. Fortunately the San Diego Line, which represents only one-half of one percent of Amtrak's route mileage, is unique. The only other line segment that approaches this mix of potential problems is between Miami and West Palm Beach.

The "out of slot" explanation for late trains is still used by certain railroads as an explanation for late passenger trains.

If we assume for discussion purposes that the original premise was correct, the "out of slot" theory would, most likely, have more validity in time table and train order territory with automatic block signals or without signals (dark railroad). Such territory does not represent a significant portion of the Amtrak system and where it does exist it is likely to be a line with moderate to light traffic density.

Traffic Control Territory

Train dispatching has changed dramatically in the past four decades from traditional practices to traffic control systems. TCS now represents the preponderance of the territory over which Amtrak operates, approximately 75%. Our premise is that even if the "out of slot" theory had merit, it would not apply in traffic control territory. A summary of carrier mileage and signal systems is attached as Appendix II.

In traffic control (TCS) territory, the train dispatcher remotely controls certain key signals and switches including the access to sidings to facilitate meets and powered crossovers to cross from one main track to another.

Unlike traditional time table and train order (now track warrant) territory, in TCS territory the dispatcher can change the route normally without communicating with the crews and with only minimal delay or with no delay if planned sufficiently in advance.

If two passenger trains normally meet at the controlled siding at B and one or the other is delayed, the meet moves either to the siding at A or at C, depending upon which train is delayed. In like manner, the far more frequent occurrence of freight train and passenger train meets should occur at whatever siding is most practical to facilitate the meet.

Although there is a growing trend to more precisely schedule key freight trains, even those trains do not normally maintain precise schedules, and meets fit into the Siding A, B or C example stated above. Other freight trains, probably the preponderance, operate on less precise schedules or no schedules at all, and therefore the meets with other trains occur on a random basis, generally depending upon the priorities accorded to each train.

If the dispatcher accords the passenger train the priority to which it is entitled in TCS territory, the whole concept of flexibility and control mitigates against the "out of slot" theory having validity.

The Study

We evaluated the operation of 581 Amtrak trains over 540,000 train miles on seven major carriers.

We generally excluded trains where the performance could be distorted by commuter operations. Because the study needed a mix of late trains and on time trains, we also excluded those routes where the trains normally depart on time even if they encounter significant delays en route. Or conversely, where trains operated consistently late, they were not included.

For this study a train was considered on time if it departed within 15 minutes of its scheduled time. The 358 on-time trains evaluated averaged 2.9 minutes late out of their initial point, while the 223 late trains averaged 59.7 minutes late out of their initial point.

A route was not excluded if it contained other than traffic control territory. As a result, the study includes a mix of TCS, automatic block signal (AS) and non-signalized (dark) territory.

The routes evaluated were as follows:

<u>Railroad</u>	<u>Trains</u>	<u>Line Segments</u>
Conrail	Trains 48 and 49	Poughkeepsie and Chicago
Conrail	Train 29	Pittsburgh to Chicago
NS	Train 19	Washington to New Orleans
UP	Train 25	Denver to Portland
CP-Soo Line	Trains 7 and 8	Minneapolis and Chicago

Santa Fe	Train 3	Chicago to Los Angeles
BN	Trains 5 and 35	Chicago to Denver
CSX	Train 81	Washington to Tampa
CSX	Train 2	New Orleans to Miami
CSX	Train 30	Pittsburgh to Washington

The results by railroad are shown in Appendix I.

We addressed the impact upon trains on the routes studied once they departed from their initial terminal on each railroad and found that on-time trains broke even, on the basis of plus or minus 10 minutes, 40.8% of the time but lost more than 10 minutes 59.2% of the time. Late trains made up over 10 minutes 17.0% of the time, broke even (± 10 minutes) 20.6% of the time and lost time 62.7% or only 3.5 percentage points greater than on-time departures. The average amount of time lost for all on time or late trains was very close at 36 minutes for on time trains and 32 minutes lost for late trains. This data is summarized in tables 1 and 2 below.

Table 1

Schedule Performance of Trains Evaluated

	Number of Trains	Made up time	Broke Even $\pm 10'$	Lost Time
On Time	358	—	40.8%	59.2%
Late Trains	223	17.0%	20.6%	62.7%

Table 2¹

Composite Summary of Time Lost

	<u>On Time Departure</u>	<u>Late Departure</u>
Trains	358	223
	<u>Average Minutes Late</u>	<u>Average Minutes Late</u>
Departure	2.9	59.7
Arrival	39.0	92.3
Time Lost	36.1	32.6

¹ for individual carrier performance see Appendix I

Conclusion

In conclusion, it appears that there is no historical statistical data that supports or refutes the traditional industry perception that "out of slot" was the rule as opposed to a random but memorable observation in years past. Therefore, it is logical to assume that historically the point as to whether it was a fact or a perception may never be proven. However, we believe a conclusion can be reached from the above statistics that today, especially in Traffic Control territory, there is no basis for the out-of-slot theory. We believe the above statistics support two conclusions, both positive:

1. The first is that out-of slot as it relates to current passenger train operations is a myth except for exceptions similar to those cited in the text; and
2. The theory that once a train is late, it is abandoned by the railroad because it cannot be restored to on-time status is also a myth that is not consistent with our data.

Summary of Time Lost

Carrier	On Time Trains				Late Trains			
	Trains	Average Departure	Average Arrival	Time Lost	Trains	Average Departure	Average Arrival	Time Lost
Conrail	173	2.5	53.1	52.6	75	52.7	107.0	54.2
NS	17	2.4	4.6	2.2	14	38.2	31.0	-7.2
UP	6	8.5	88.7	80.2	25	100.3	155.9	55.6
CP- Soo Line	38	1.9	15.2	13.3	24	65.1	87.2	22.1
Santa Fe	26	2.0	28.3	26.3	5	38.4	50.8	12.4
BN	34	2.0	35.1	33.1	26	49.9	82.1	32.3
CSX	<u>64</u>	<u>4.9</u>	<u>20.2</u>	<u>15.3</u>	<u>54</u>	<u>60.4</u>	<u>69.3</u>	<u>8.9</u>
Composite	358	2.9	39.0	36.1	223	59.7	92.3	32.6

Appendix II

System Route Mileage by Signal Type

Carrier	Total Miles	Dark	ABS	TCS or Interlocking
Conrail	1673	37	78	1558
Metro North	131	-	-	121
Norfolk Southern	1361	99	222	1040
Illinois Central	962	9	132	821
Grand Trunk Western	194	-	78	116
New England Central	237	237 190	-	47
AT&SF	2646	-	1190	1456
Burlington Northern	3575	-	798	2777
CP-Soo Line	388	-	38	350
Southern Pacific including SPCSL	4512	2	1422	3088
Union Pacific	3631	47	619	2965
CSX	3565	247	34 384	2934
MBTA	38	-	-	38
Chicago Metra	34	-	6	28
CP-Delaware & Hudson	174	1	-	173
Kansas City Terminal	13	-	-	13
Minnesota Commercial	2	2	-	-
Gateway Eastern	13	-	13	-
TRRA	9	-	3	6
New Orleans Public Belt	5	-	-	5
Florida DOT	64	2	-	64
SCRRA - (Los Angeles)	14	-	-	14
LAUPT	1	-	-	1
NOUPT	6	-	-	6
Denver Union Terminal	1	1	-	-
Amtrak including CUS	<u>650</u>	<u>-</u>	<u>102</u>	<u>548</u>

Total United States	23,889	684	5,085	18,120
Carrier	Total Miles	Dark	ABS	TCS or Interlocking
Canadian Operations				
Burlington Northern	34	-	21	13
Canadian National	49	36	-	13
Via-Vancouver Term	1	1	-	-
Total Canada	<u>84</u>	<u>37</u>	<u>21</u>	<u>26</u>
System Route Miles	23,973	721 674	5,106	18,146 93
Percentage	100%	2.8 3.0%	21.3%	75.7 75.7%